



Armed Forces College of Medicine AFCM



Respiratory System

Dr. Sara Abdel Elgawad
Prof. of Histology and Cell Biology

INTENDED LEARNING OBJECTIVES (ILO)

By the end of this lecture, you should be able to:

- List the components of the **conducting & respiratory portions** of the respiratory system.
- Describe the structure and correlated functions of the **olfactory mucosa**
- Describe the structure and correlated functions of the **respiratory mucosa**.
- Correlate the defective microscopic structure of **respiratory epithelium as a result of smoking**.
- Compare between layers of the wall of **the trachea and bronchi**.



1. Part 1 (5 min) Introduction

2. Part 2 (35 min) Main lecture: Key points:

- Nasal cavity.
- Olfactory epithelium.
- Structure of the trachea.
- Respiratory epithelium.
- Structure of intrapulmonary bronchi.

3. Part 3 (5 min) Summary

Components of Respiratory System



CONDUCTING PART

Nose

Nasopharynx

Larynx

Trachea

Bronchi

**Bronchioles
Pre-terminal &
(Terminal)**

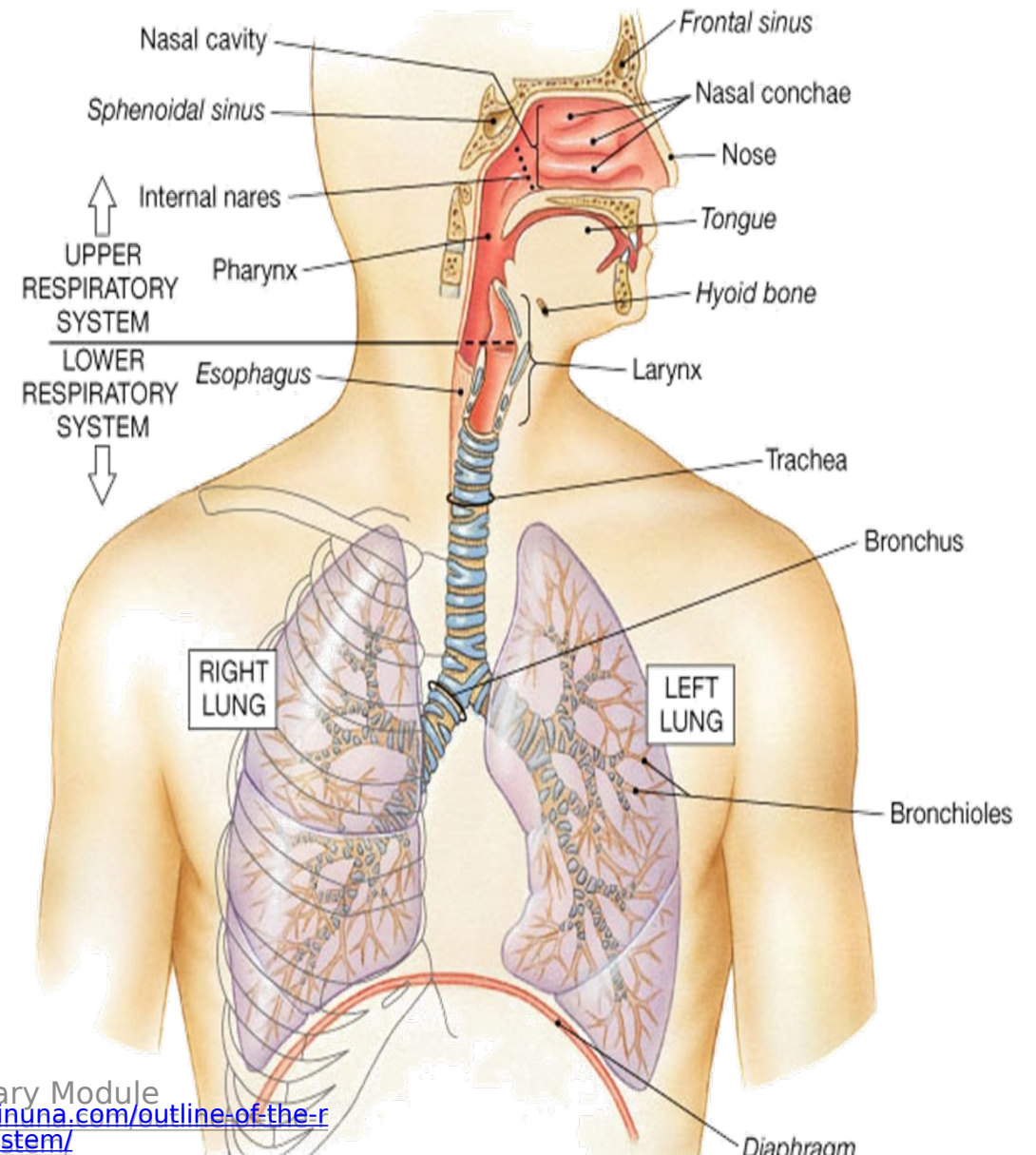
RESPIRATORY PART

**Respiratory
Bronchioles**

**Alveolar
duct**

Alveolar Sac

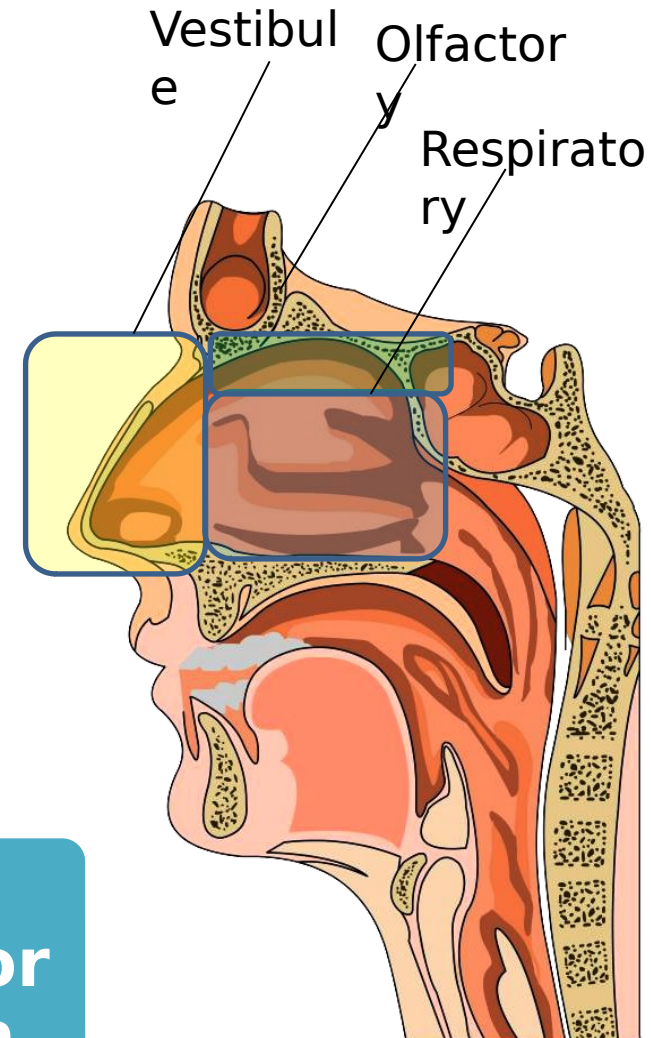
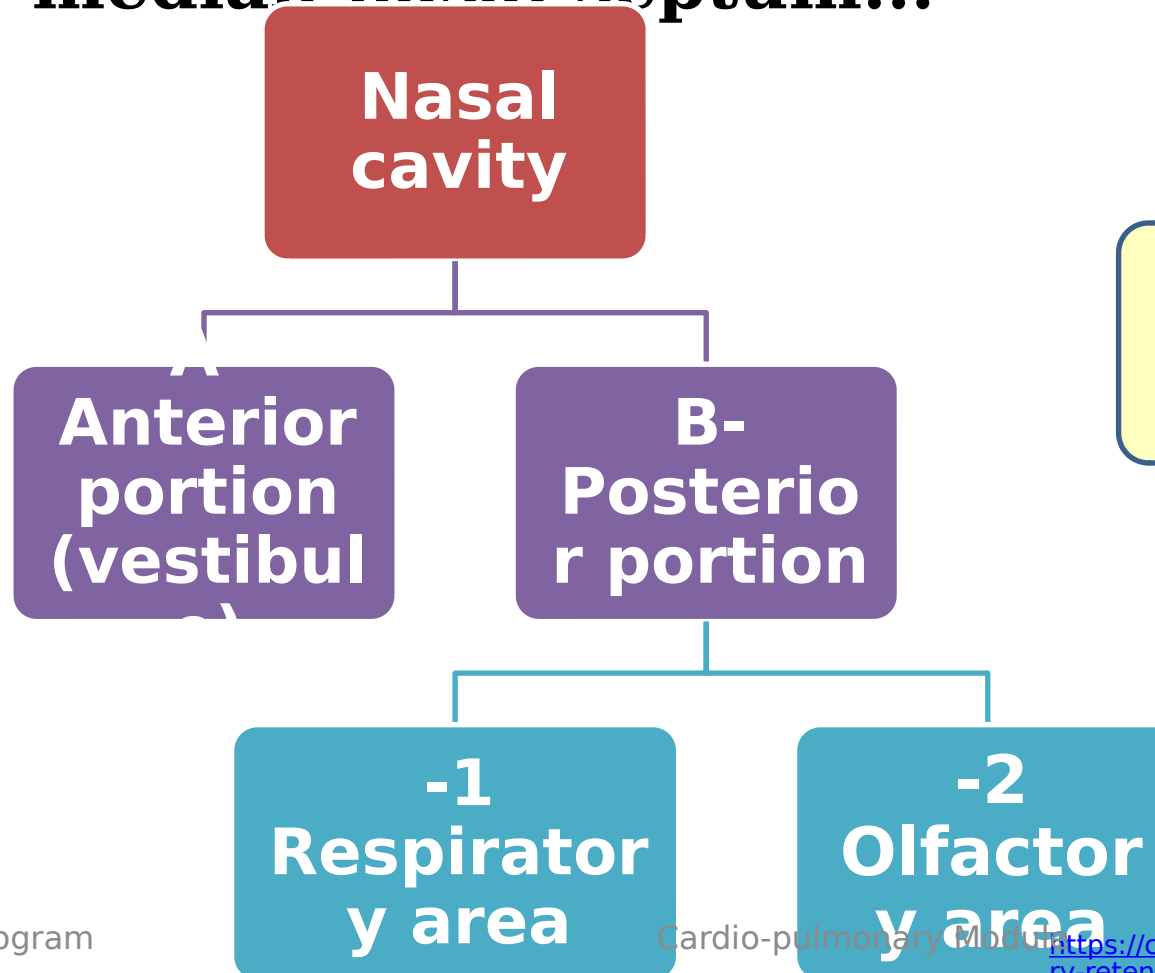
Alveoli



1- Nose



- It is divided into right and left nasal cavities by a median nasal septum...



1- Nose



A- The anterior part of nasal cavity (the Vestibule)

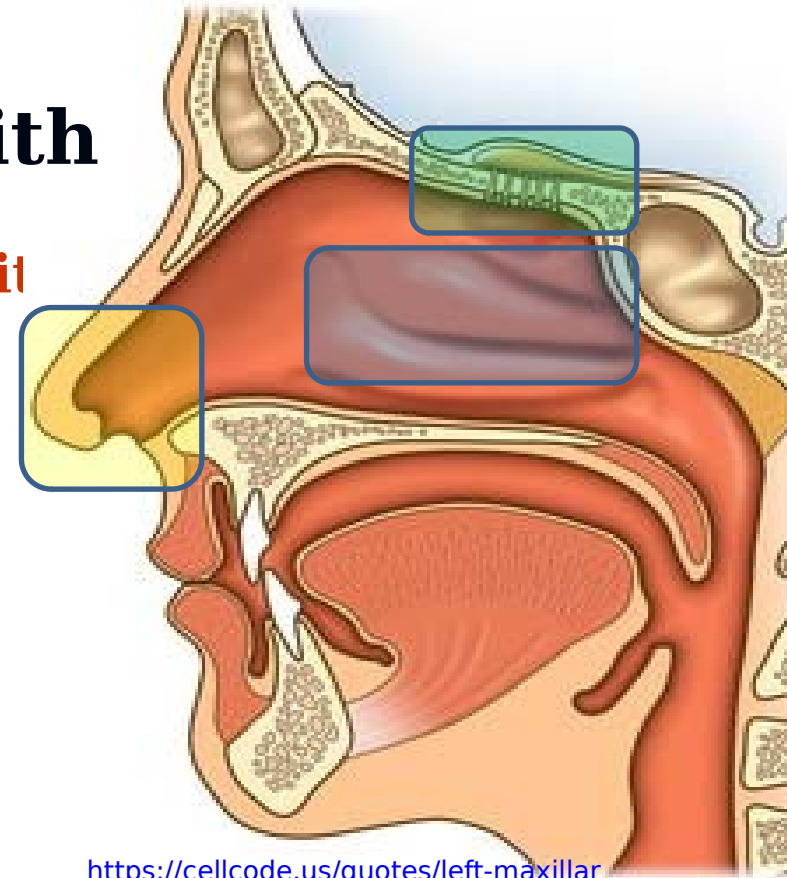
It is lined with skin (epidermis & dermis) with short stiff hairs

B- The posterior part of nasal cavity

It is divided into two areas:

1-Olfactory area:
presents in the roof of the nasal cavity

2-Respiratory area:
includes all the nasal



<https://cellcode.us/quotes/left-maxillary-retention-cyst.html>

1- Nose



1- The respiratory area

It is lined by mucous membrane

2-Lamina

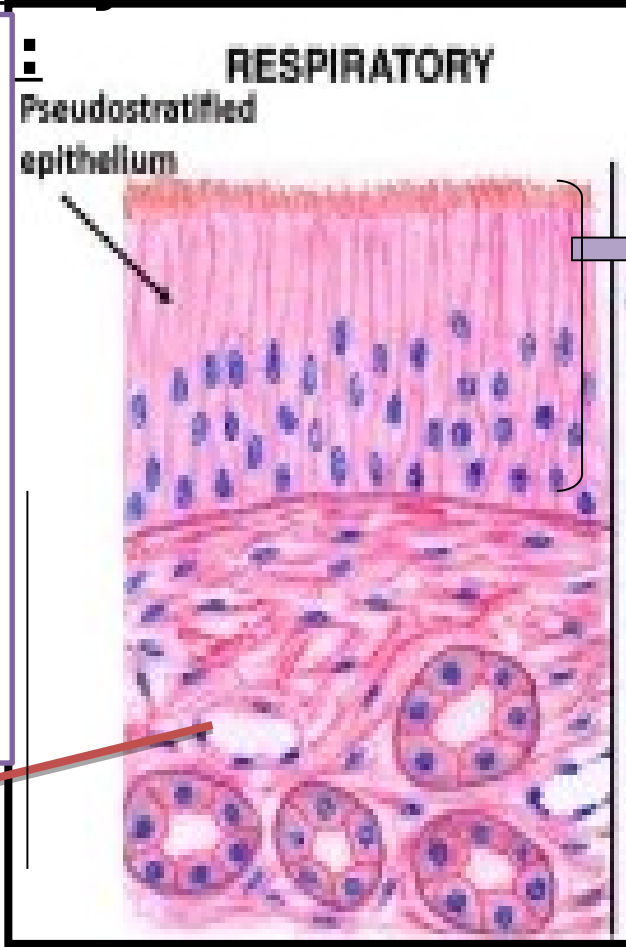
propria: dense fibroelastic C.T.

- **Highly vascular**
- **Contain**

seromucous glands → watery secretion

→ humidify inspired air
The high vascularity is for warming of the

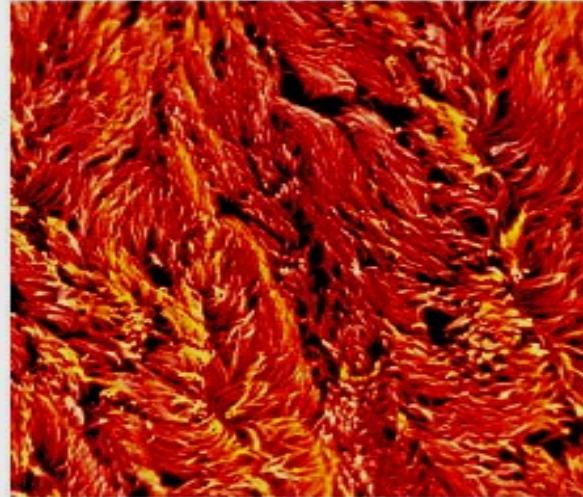
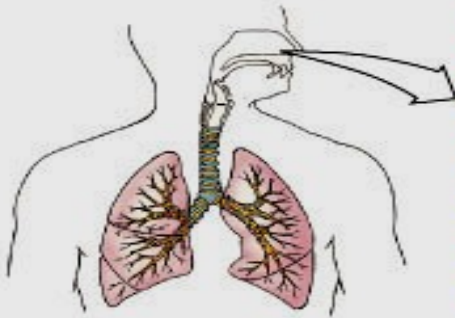
inspired air



1- Respiratory epithelium:

- Pseudo-stratified columnar ciliated epithelium with goblet cells
(=Respiratory epithelium).

1- Nose



(a) Superficial view

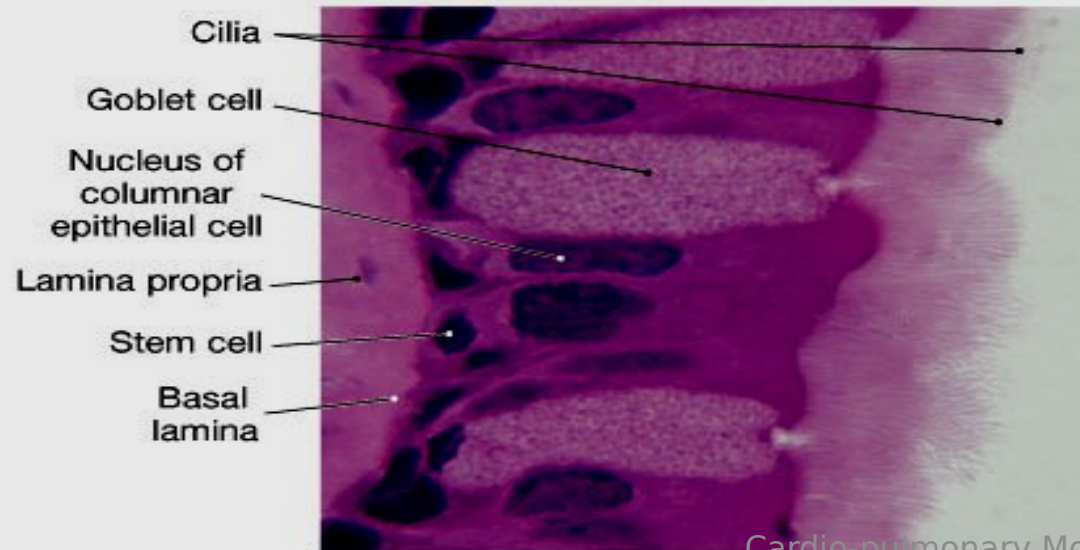


Pathogens on the tonsils and nose trying to descend

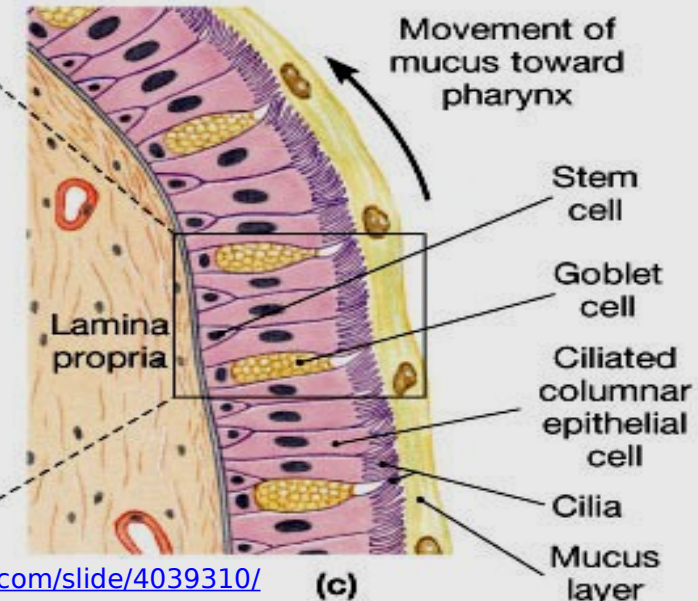
The mucociliary escalator

Upward movement of escalator

Mucociliary escalator



(b) Sectional view



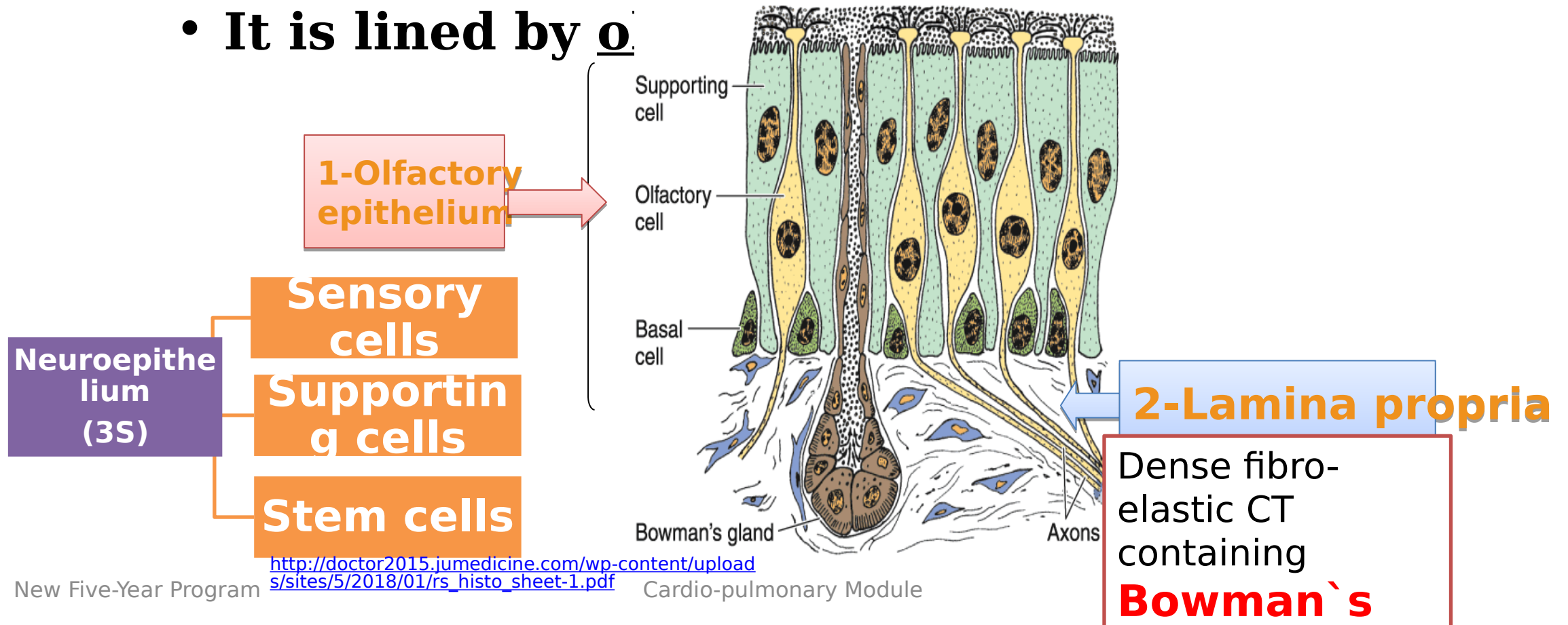
(c)

1- Nose



2- The olfactory area

- Site: It is present in the roof of the nasal cavity
- It is lined by o



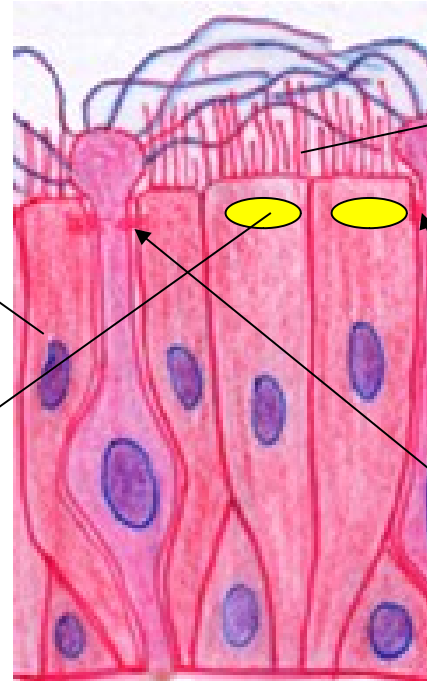
1- Nose



Olfactory epithelium (Neuroepithelium)

1-Sustenticular (supporting cells)

• Tall columnar cells with oval **apical nuclei**



• Apical microvilli trapping thin serous fluid.

• The apical **cytoplasm** has few pigment granules responsible for **yellow color** of olfactory epithelium

<http://www.anatomyqa.com/histology/respiratory-system/>

Junctional complex

Function

Support, Insulation of the olfactory cells and Nutrition

1- Nose

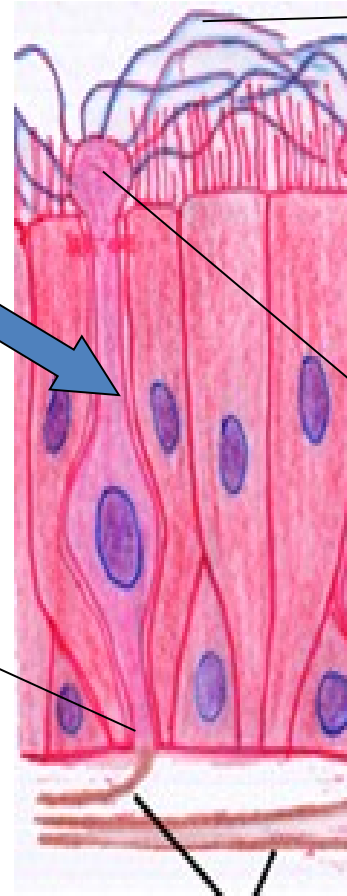


The olfactory epithelium

2-Olfactory (chemoreceptor) cells:

They are **bipolar neuron**.

Their **unmyelinated axons** → lamina propria → olfactory nerve → CNS



Cilia are **long**, **non motile** and lie **flat** on the epithelial surface.

Their **dendrites** are modified forming a **bulb (Olfactory vesicle)** arising from it 6-8 cilia.

It contains the basal bodies of the cilia, mitochondria and rER

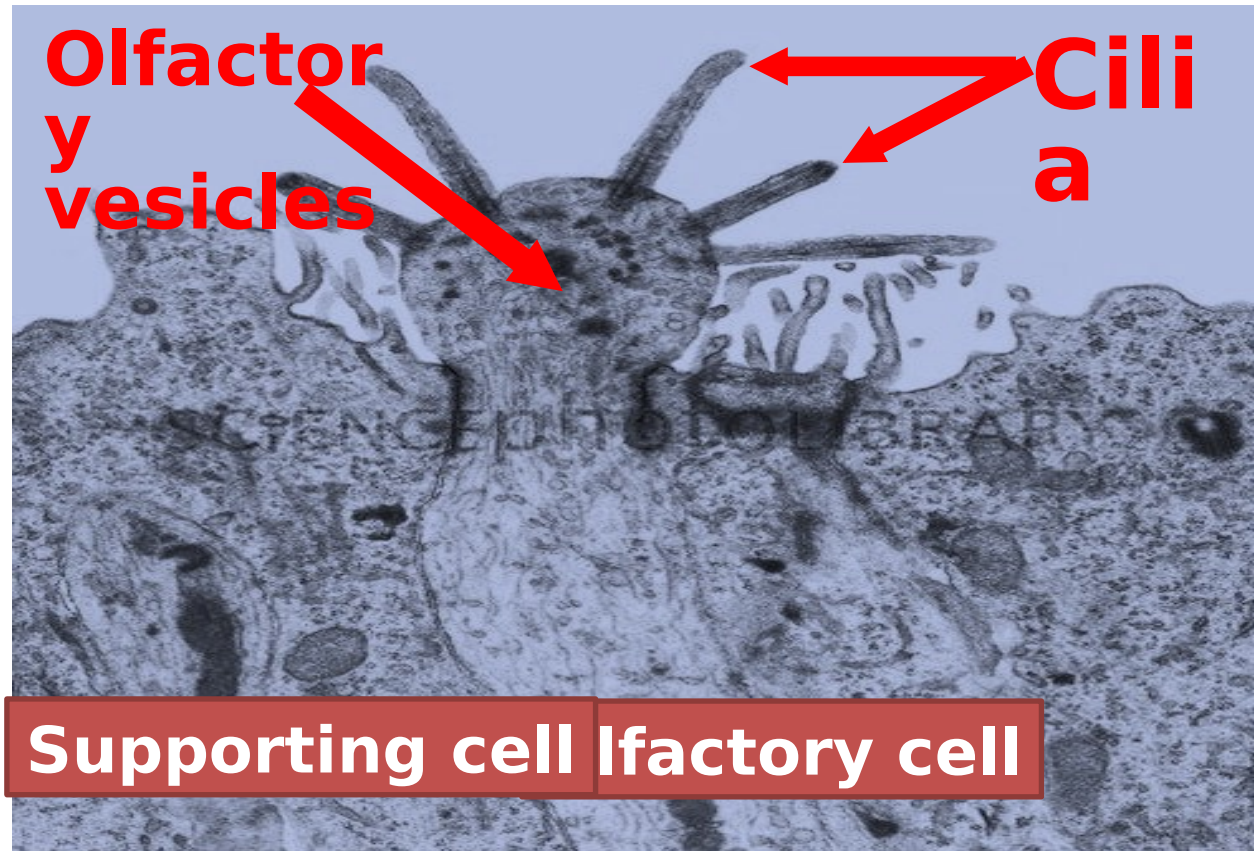
Olfactory cells processes

1- Nose



The olfactory epithelium

2-Olfactory (chemoreceptor) cells:



1- Nose

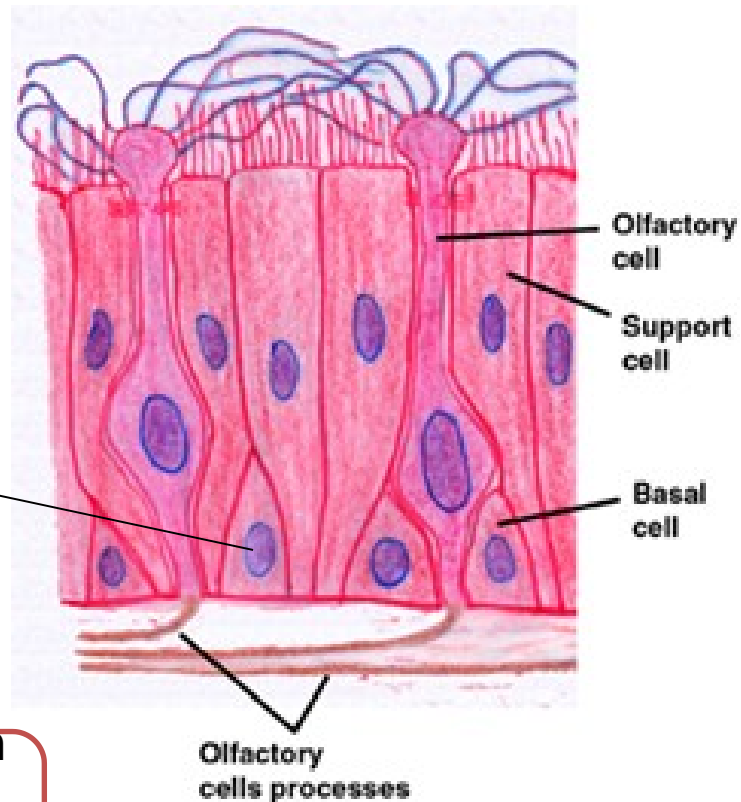


The olfactory epithelium

:The basal cells (reserve or stem cells)-3

**They are
small cells
not reaching
the surface**

These cells have been
used in clinical trials
for adult stem cells
.treatment



Function:
They can
divide &
regenerate
olfactory
neurons
every 2-3
months.

1- Nose

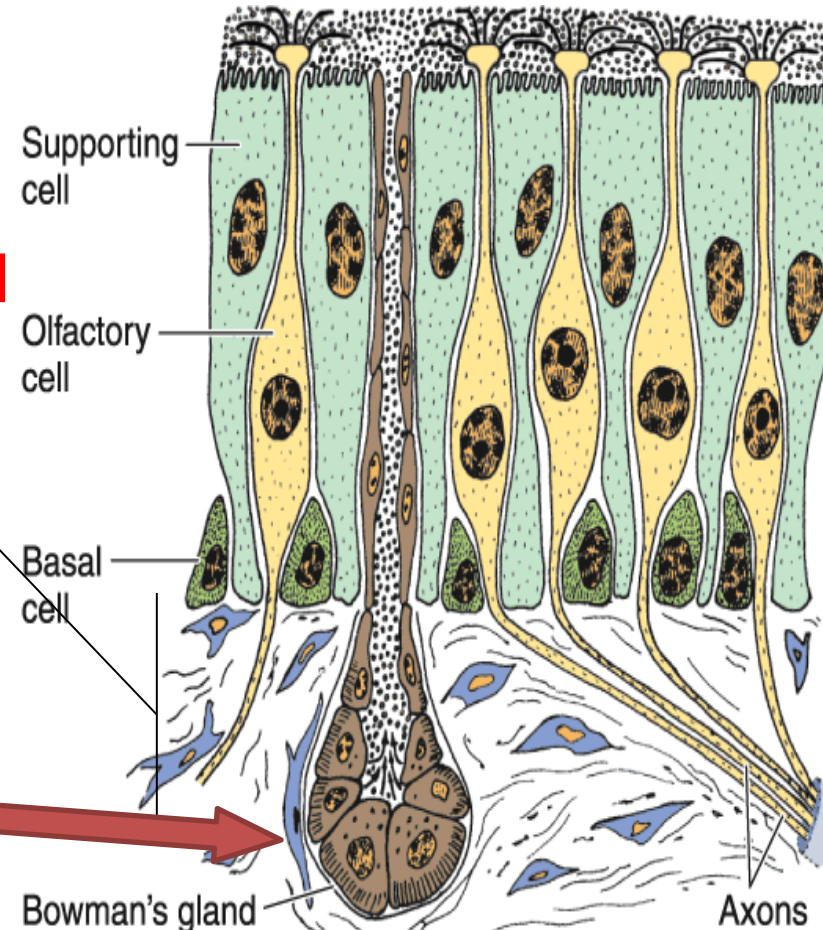


Lamina propria of the olfactory area:

Lamina propria:
dense fibro-elastic CT.
Contains **Bowman's gland**

It produces watery **(serous)** secretion:

1. Solvent for odorous gases
2. Clear the epithelium for new stimulus.



<http://doctor2015.jumedicine.com/wp-content/uploads/sites/5/2018/01/rs-histo-sheet-1.pdf>



Medical Application



Anosmia / Hyposmia

- Loss or reduction of the ability to smell can be caused by common cold or flu. Recovery is temporary????



**Due to regenerative activity of the olfactory
basal stem cells**

Paranasal sinuses



- Are bilateral cavities in the frontal, maxillary, ethmoid, and sphenoid bones of the skull.
- They are lined with respiratory epithelium.
- The paranasal sinuses communicate with the nasal cavities through small openings; mucus produced moved into the nasal passages by the activity of the ciliated cells.

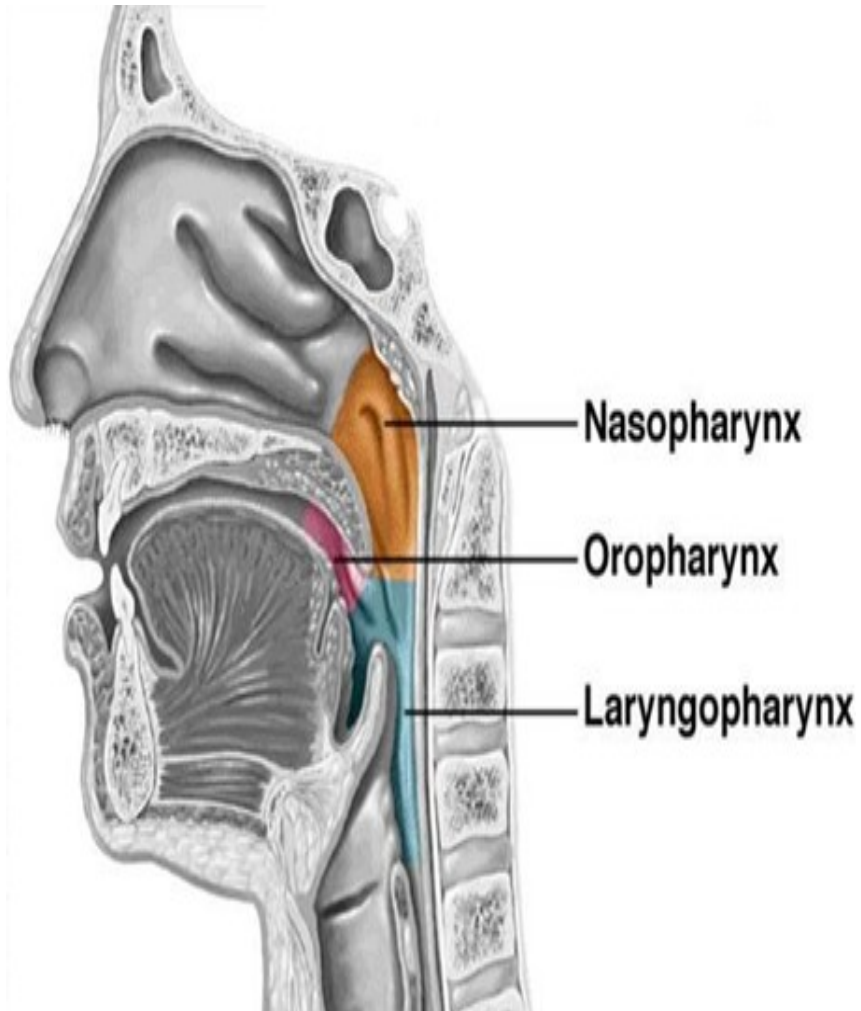


❑ ***Sinusitis*** is an inflammatory process of the sinuses, mainly because of obstruction of drainage orifices.

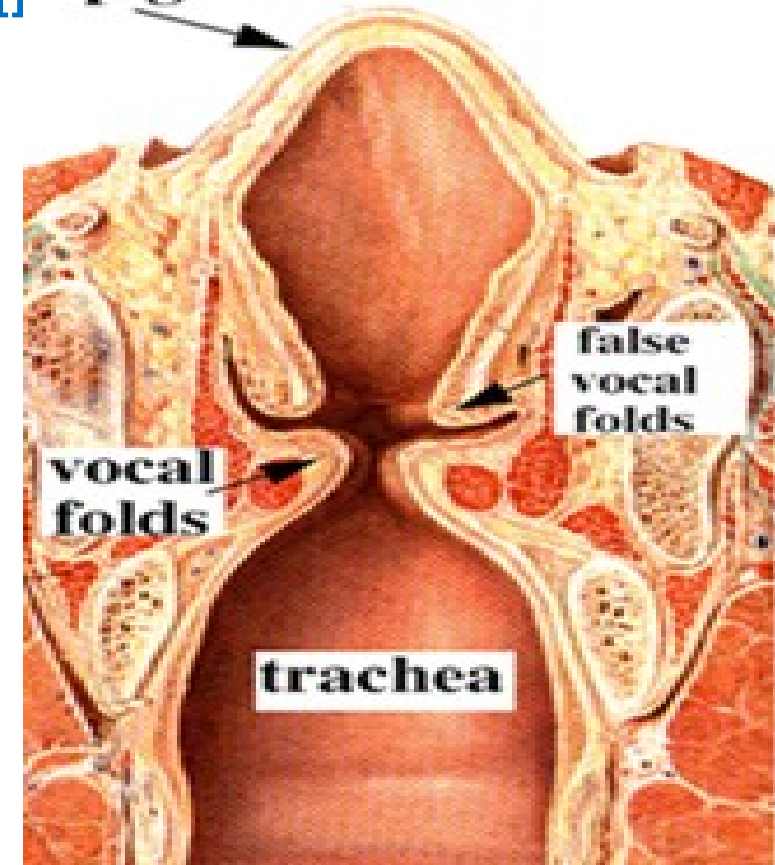
2- Nasopharynx Larynx



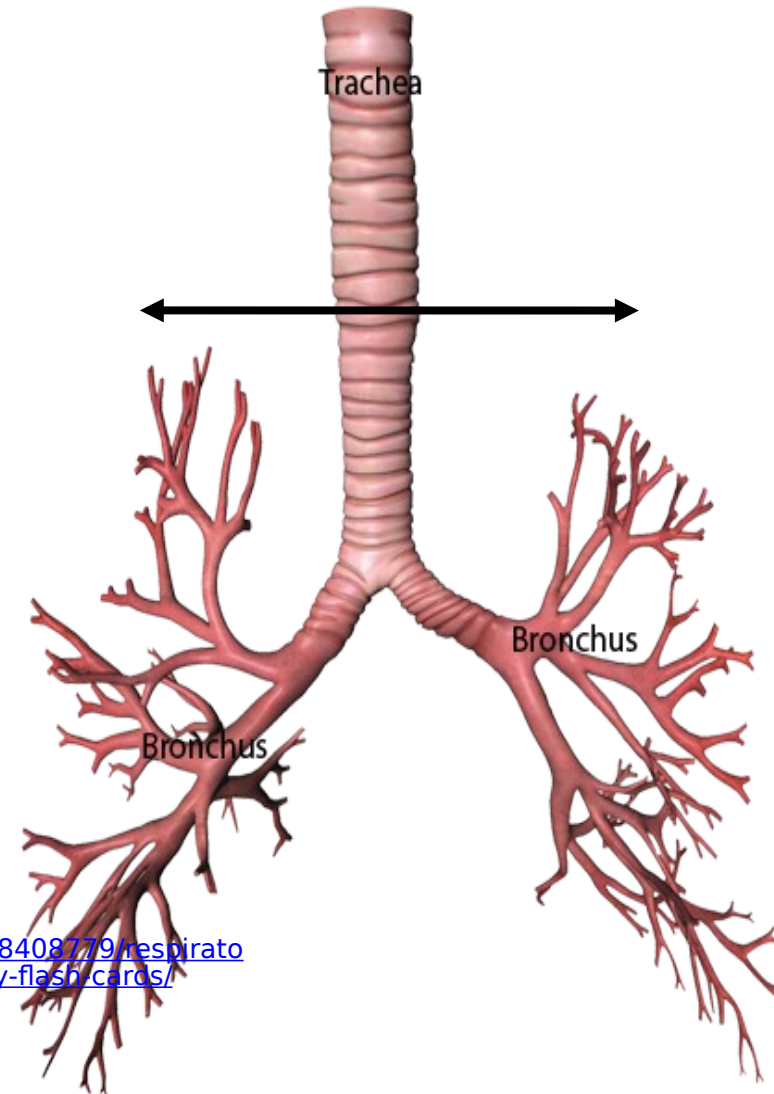
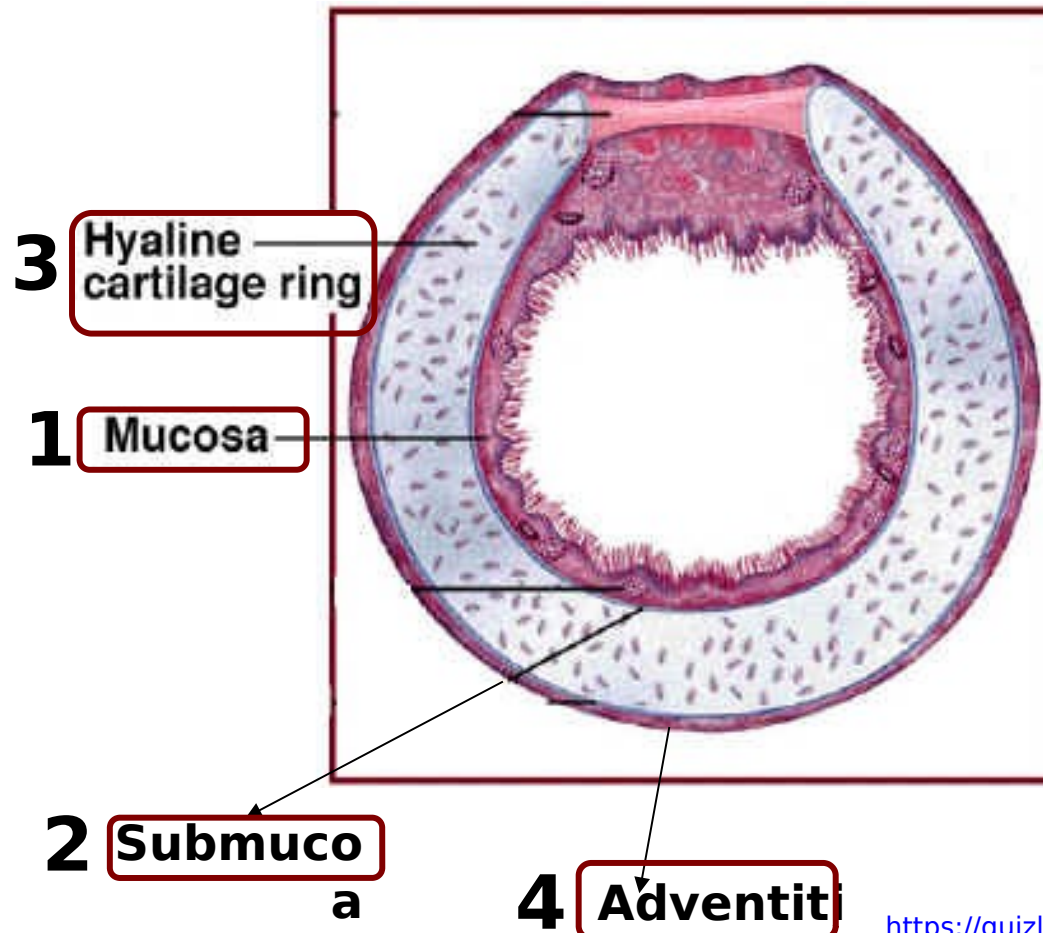
- Lined by respiratory epithelium



Lined by respiratory epithelium
except vocal cords → lined by **st. sq. ep.**
non epiglottis



4- Trachea



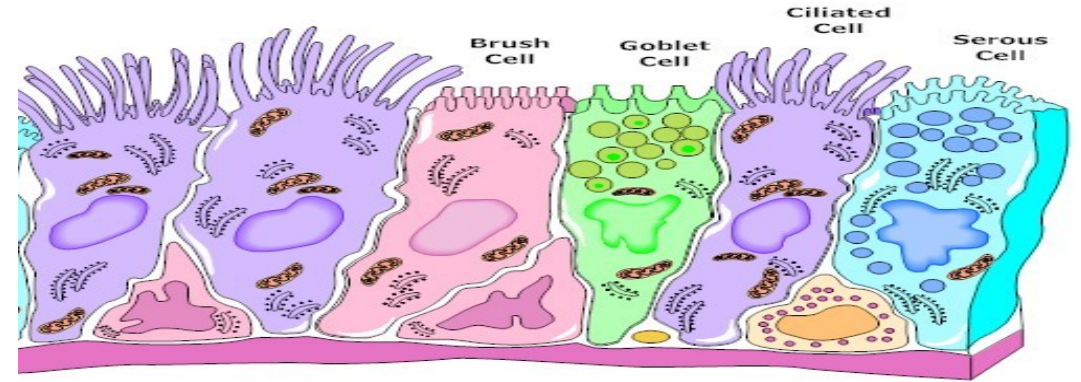
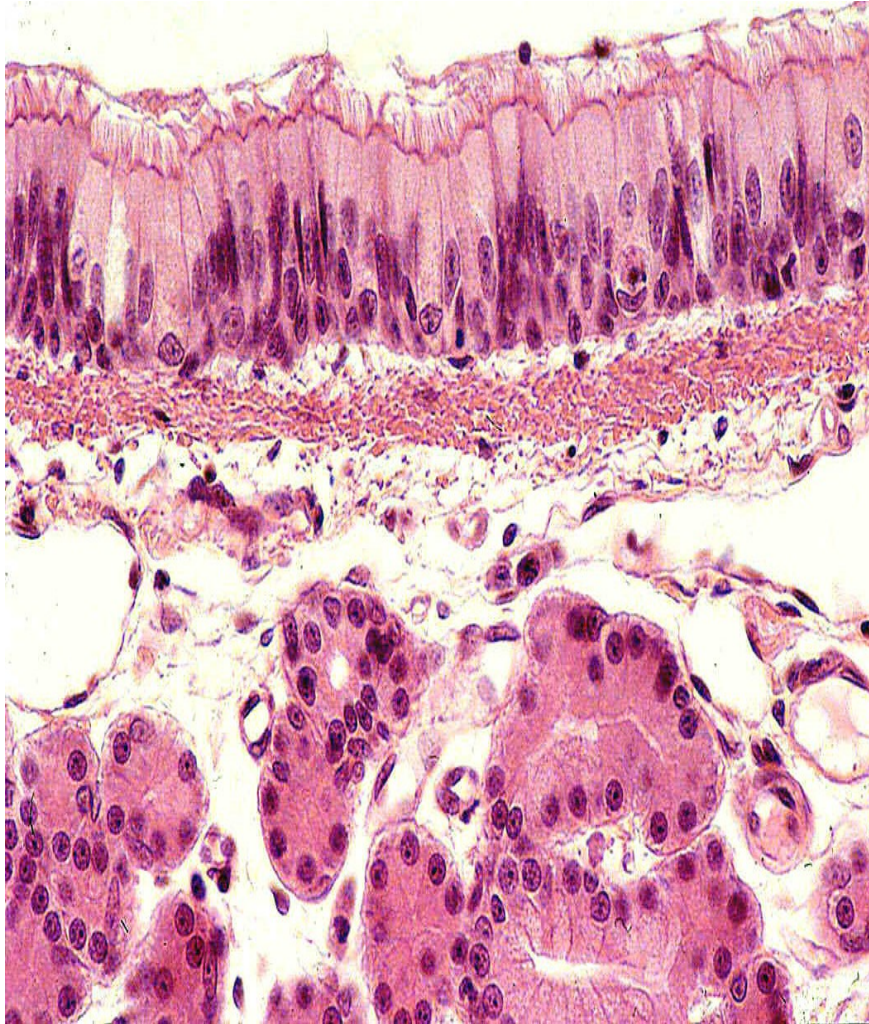
The open ends of the cartilage rings are on the posterior surface, against the esophagus, and are bridged by a bundle of smooth muscle called the **trachealis muscle**.

<https://quizlet.com/68408779/respiratory-flash-cards/>

4- Trachea



Mucosa of the trachea-1



<https://www.slideserve.com/abiola/respiratory-syst>

A) Respiratory epithelium
(5 types of cells)

B) Lamina propria:
CT rich in lymphocytes

It contains **elastic membrane** separating the mucosa from submucosa. It is responsible for elastic recoil of the trachea after expiration

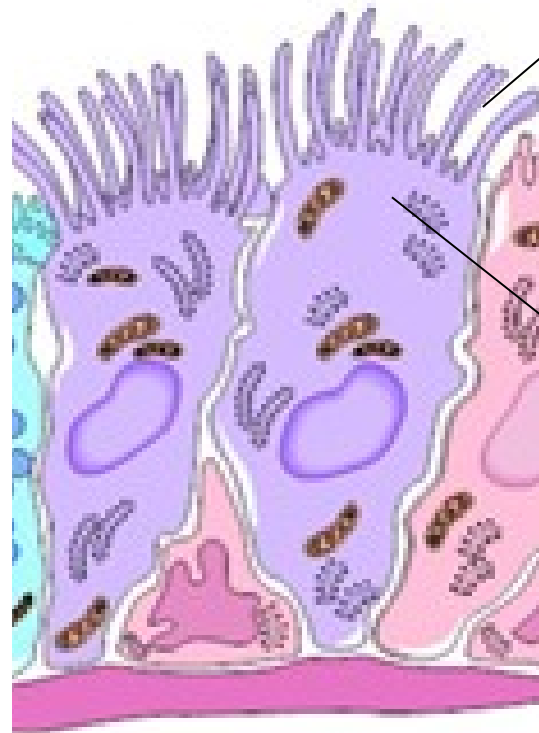
4- Trachea



Respiratory epithelium (5 types of cells):
pseudo-stratified columnar ciliated with goblet cells

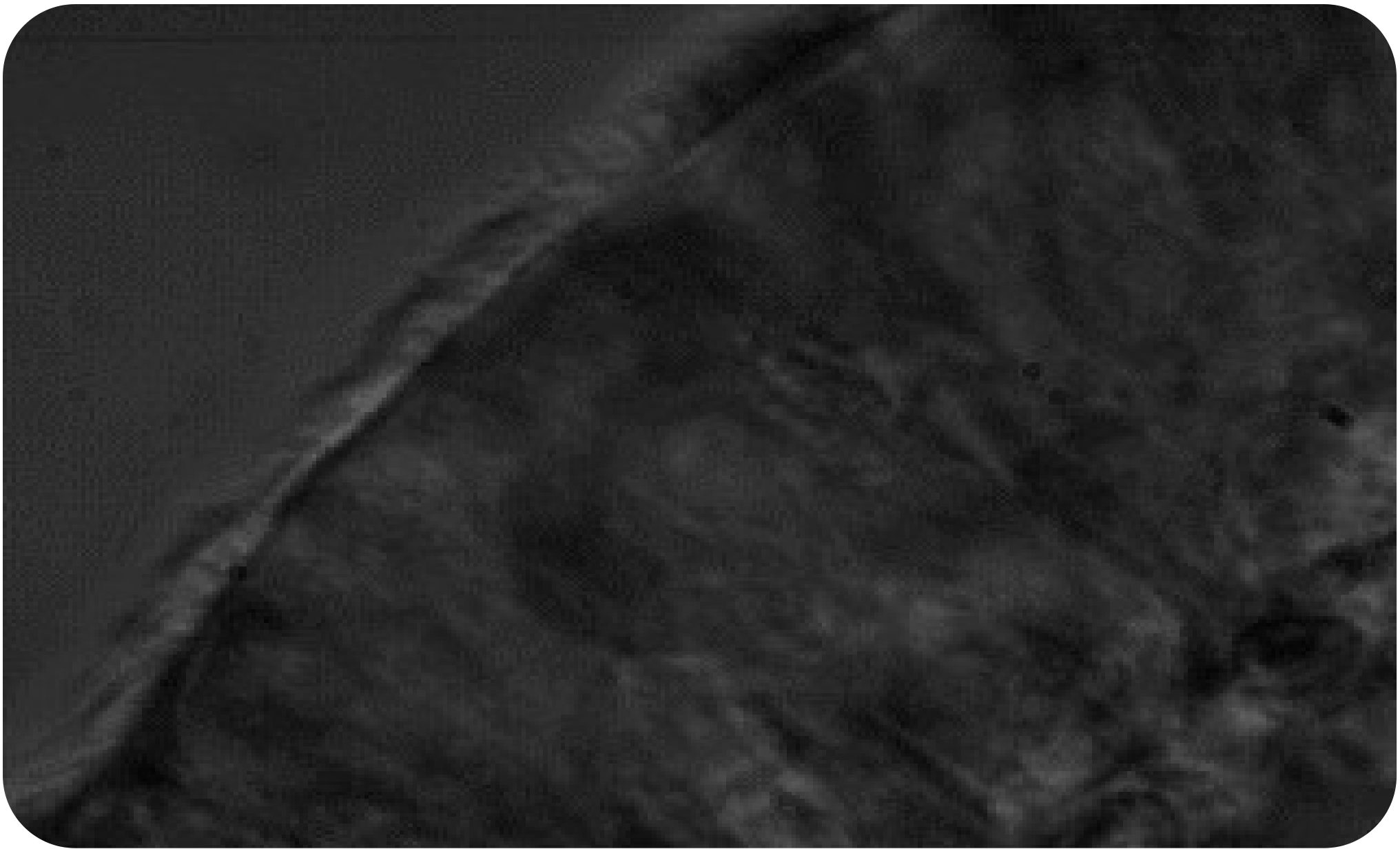
1-Ciliated columnar cell (30%):

It is tall columnar cell with basal oval nucleus.



• Its apical surface is provided with **200-300 cilia** (beat toward the larynx).

The **apical cytoplasm** contains **basal bodies of cilia** and **many mitochondria**



<https://www.ciliopathyalliance.org/cilia>

New Five-Year Program

These cilia have a rhythmic waving or

Cardio-pulmonary Module

4- Trachea

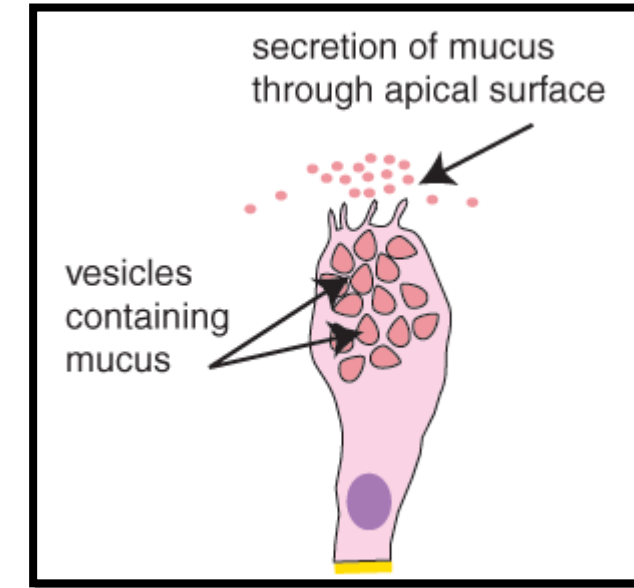
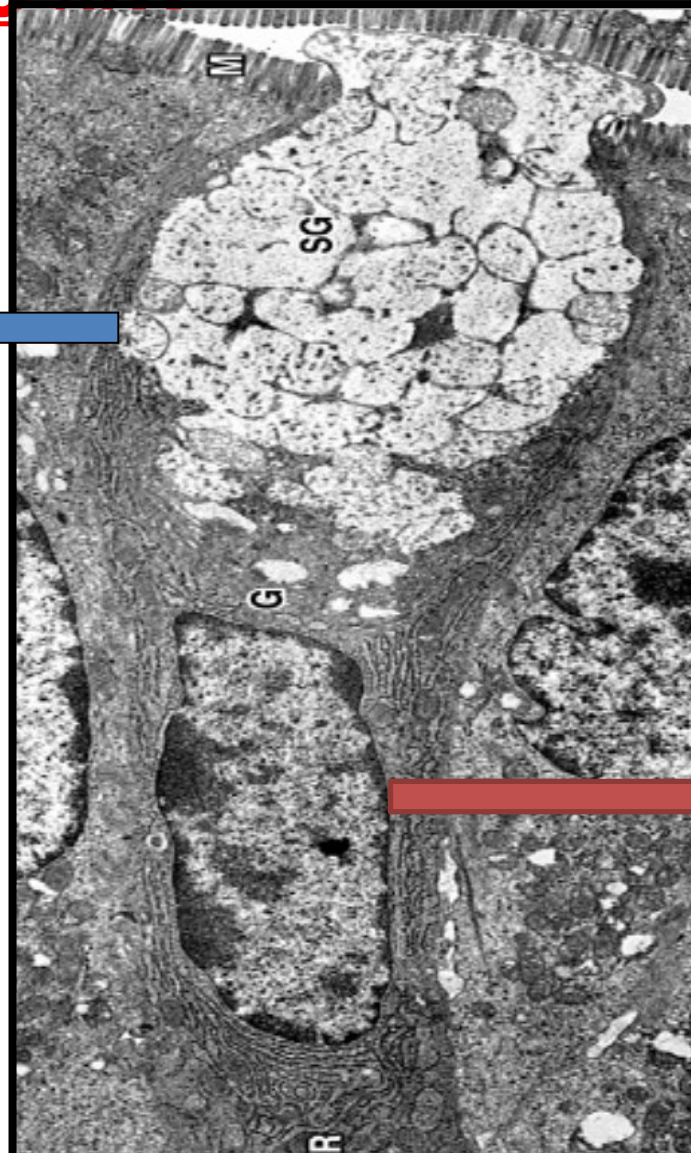


2-Goblet cell (30%)-

It has
expanded
apical part
filled with
**mucinogen
granules**



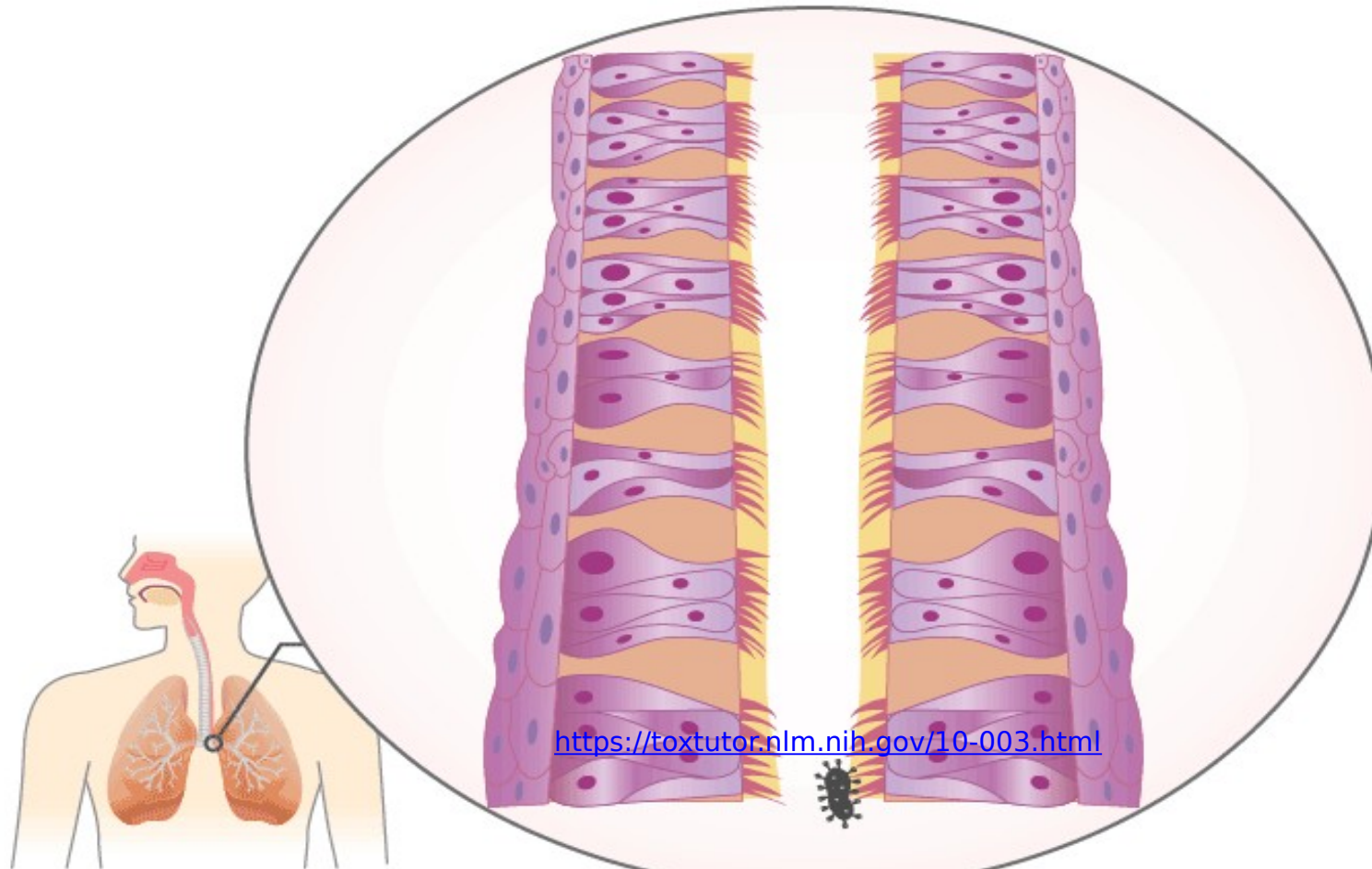
In cystic fibrosis, the secreted mucous is thick or viscous and the cilia have a difficult time moving it toward the pharynx. Patients with this disease have frequent infections of the



https://www.histology.leeds.ac.uk/tissue_type/s/epithelia/epi_goblet_cell.php

The narrow
basal part of
the cell
contains the
nucleus, rER,
Golgi
complex and

4- Trachea

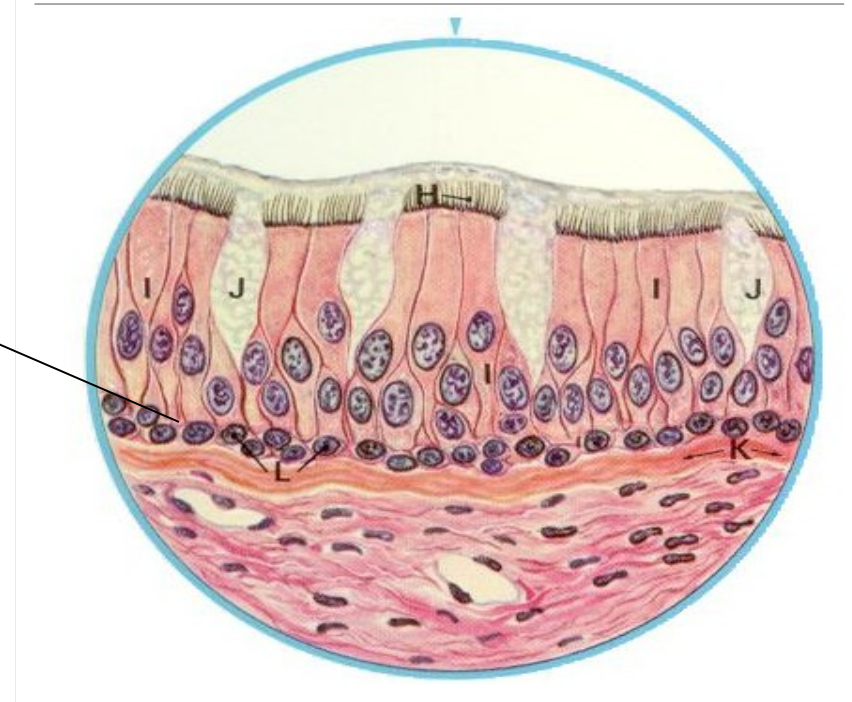
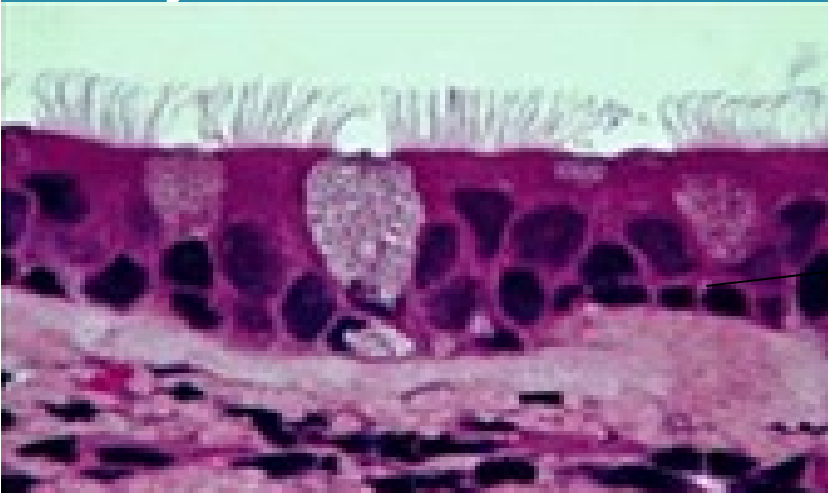


4- Trachea



3-Basal stem cell (30%):

- They are small rounded cells located on the basal lamina and not reaching the surface.
- They have **free**



https://link.springer.com/chapter/10.1007/978-3-211-99390-3_104

They can differentiate into ciliated and goblet cells

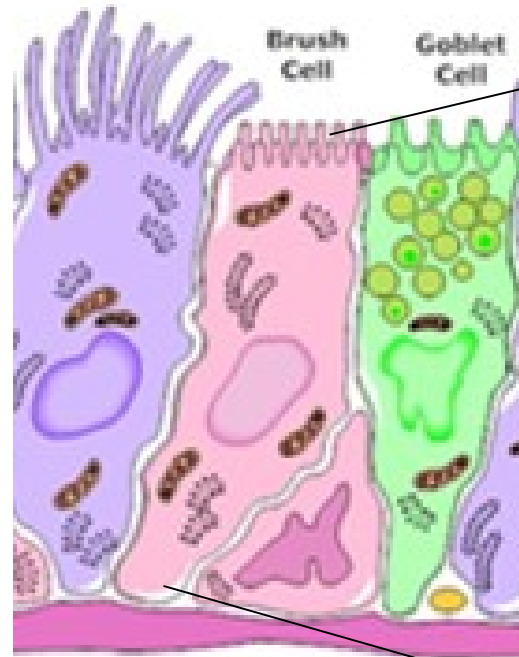
4- Trachea



4-Brush cell (3%):

• They may act as:
Sensory chemorecept

Brush cells may represent goblet cells that have secreted their products or intermediate stages in the formation of goblet or the tall ciliated cells.



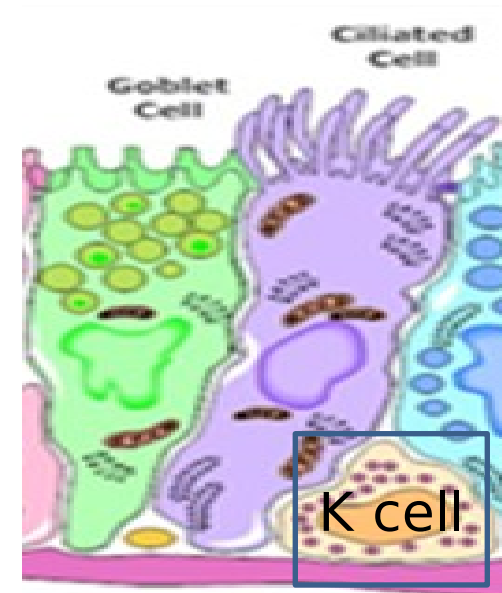
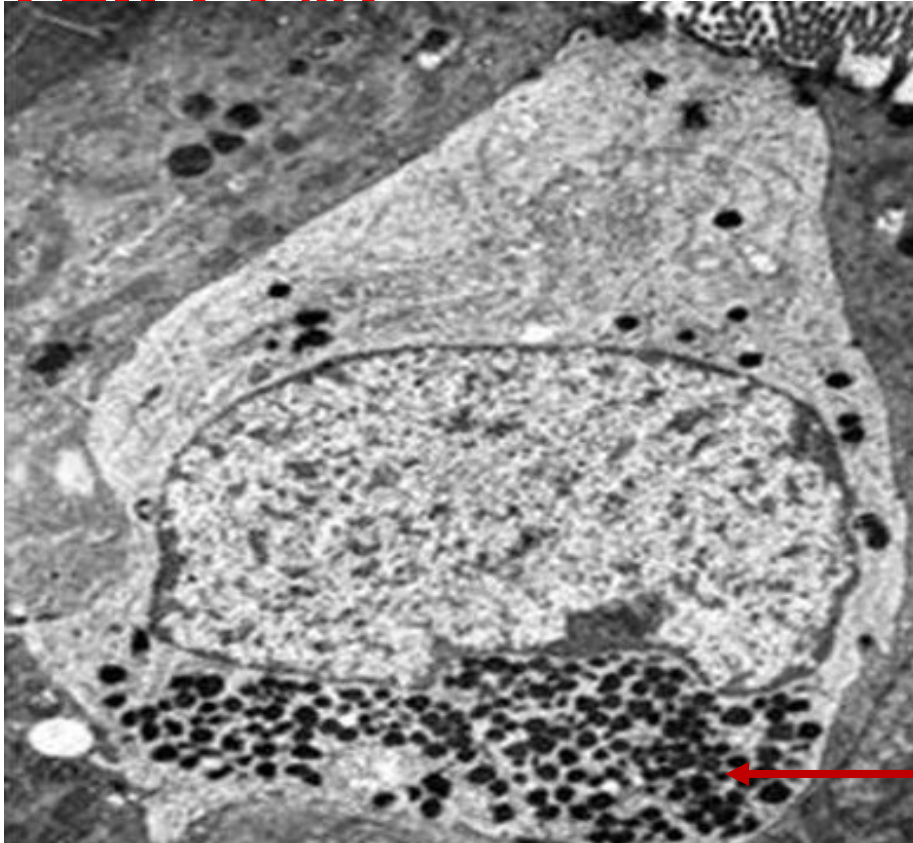
• Columnar cell with short microvilli.

• There are **nerve endings** on their basal surface

4- Trachea



5- Neuroendocrine cells (DNES), Kulchitsky cell or K cell (3%)



- Contain **basal** electron dense secretory granules to be released in blood vessels in L.D.

- Function: They release **serotonin, bombesin**.

Clinical Correlate

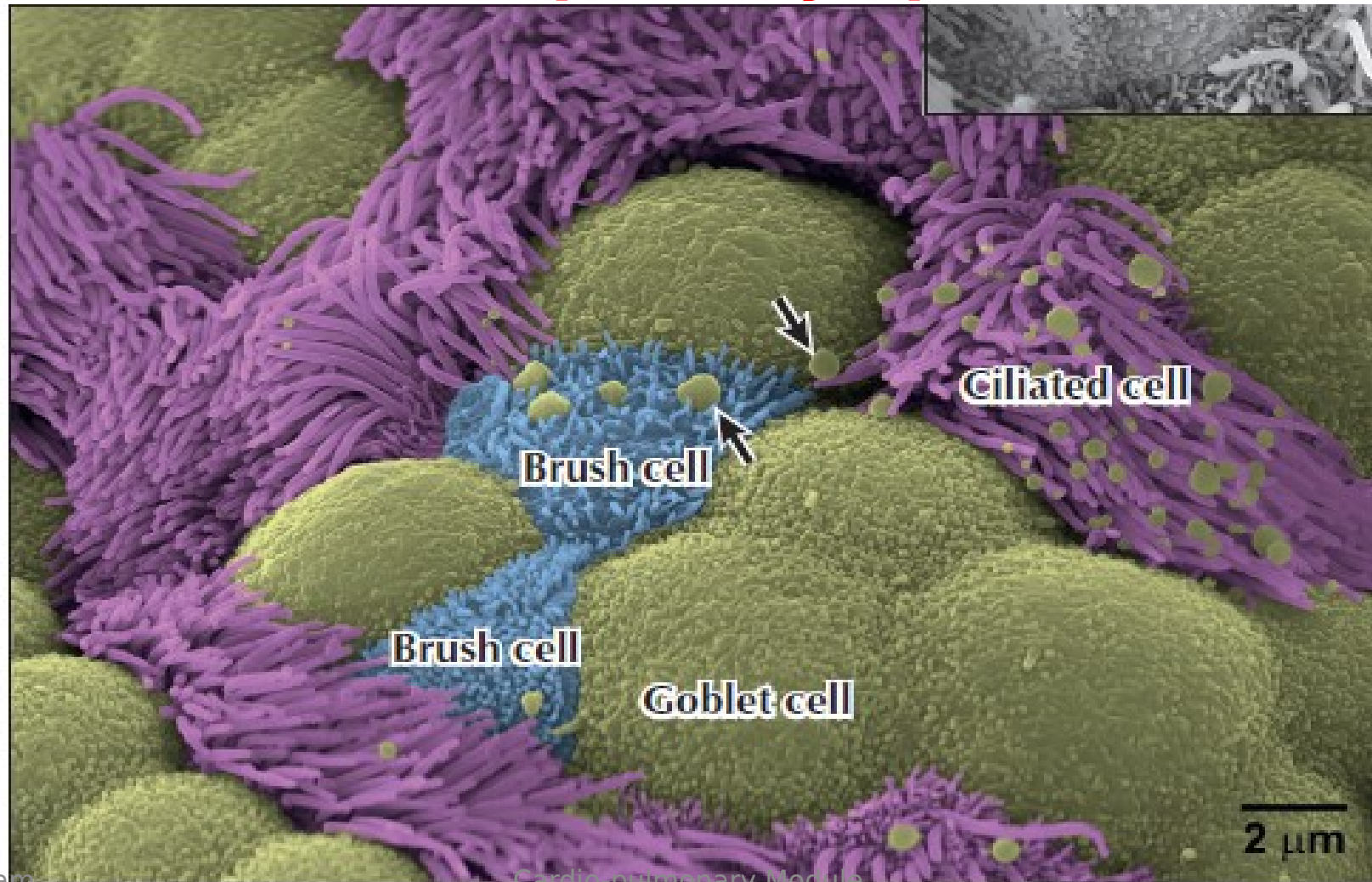
Bronchial metastatic tumors (small cell carcinoma) arise from Kulchitsky cells.



4- Trachea



SEM of respiratory epithelium



4- Trachea



**2- submucosa:
dense irregular
fibroelastic CT.**

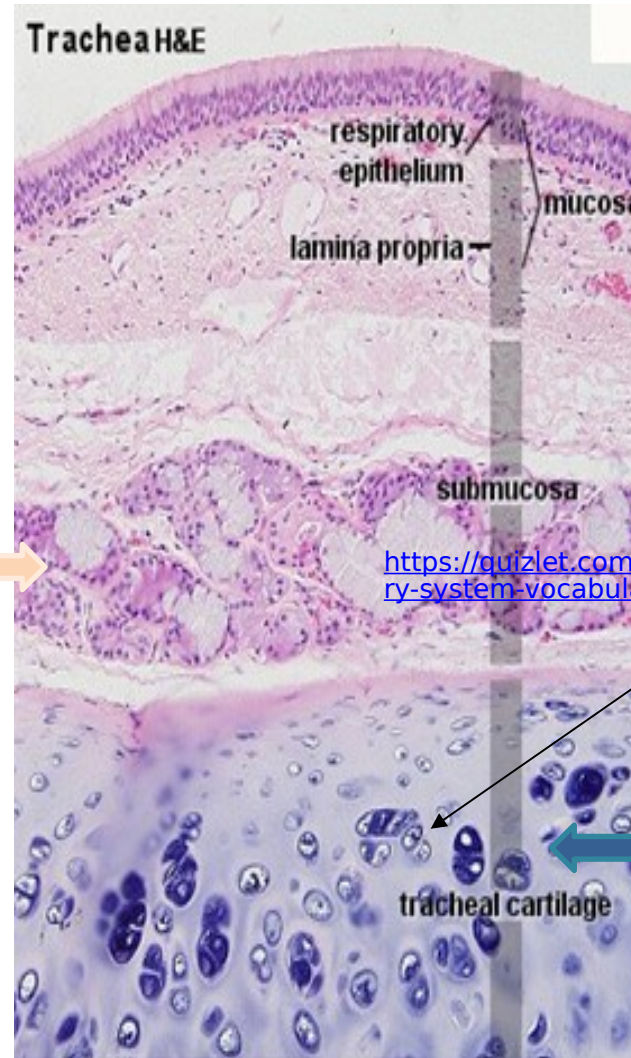
•It contains:

- 1. Lymphatic nodules.**
- 2. seromucous**

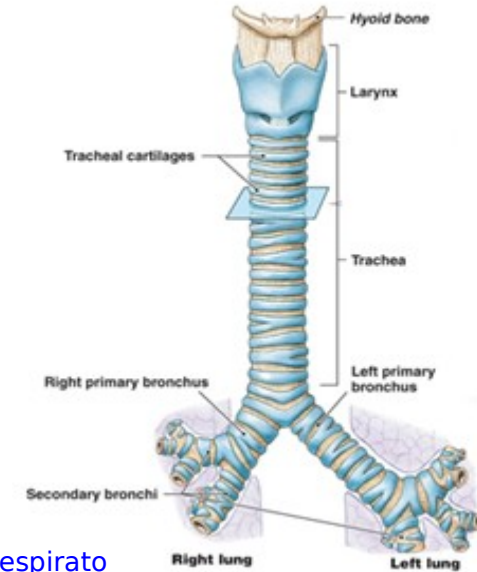
4- Adventitia

3. Blood vessels

<https://brainiacs.com/mucous-connective-tissue-histology-5c148d628719620724ae2c04/>



<https://quizlet.com/68408779/respiratory-system-vocabulary-flash-cards/>



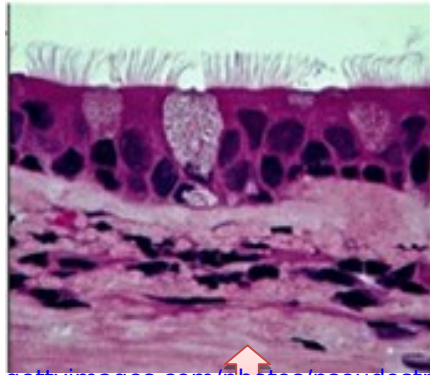
**3- Fibrocartilage
layer: 20 C-shaped
hyaline cartilage**

Posteriorly, the ends of the cartilage rings are spanned by a fibrous membrane containing smooth muscle fibers (**trachealis**)



Medical Application

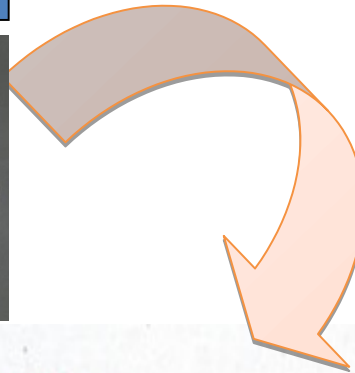
application



<https://www.gettyimages.com/photos/pseudostratified-epithelium>

Normal
respiratory
epithelium

Smoking
& coal



<https://www.slideshare.net/ananthatiger/mbbs-i-ms-msu-2519820>

↑ Goblet cells relative to
ciliated cells

Goblet cells produce
thicker mucus + ↓ number
of ciliated cells

↓ Rate of
mucous
removal

Bacterial
infection
→ chronic
bronchitis



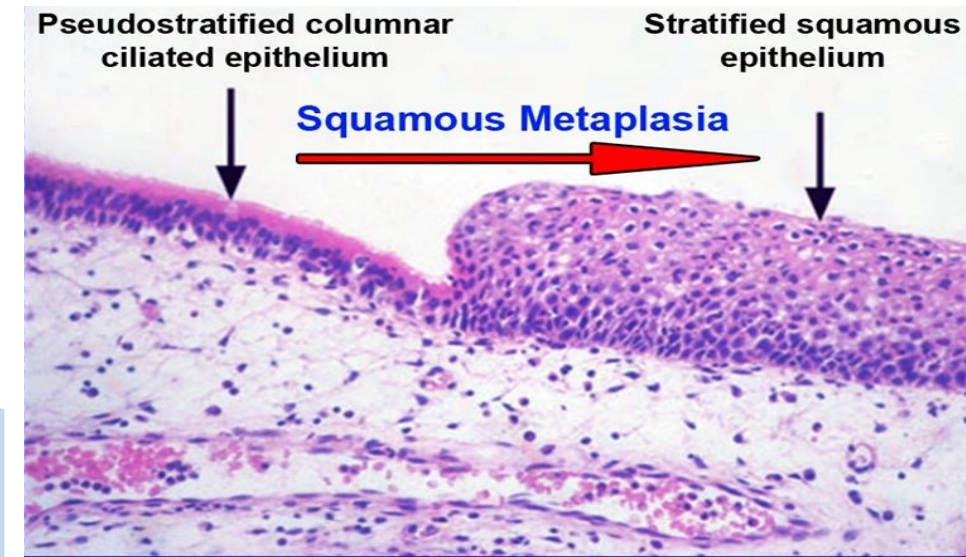
Medical Application



Respiratory metaplasia

- The respiratory epithelium of people chronically exposed to irritants such as cigarette smoke and coal dust undergoes reversible changes known as metaplasia.

Metaplasia : reversible replacement of one epithelial cell type with another one



<https://slideplayer.com/slide/5258427/>

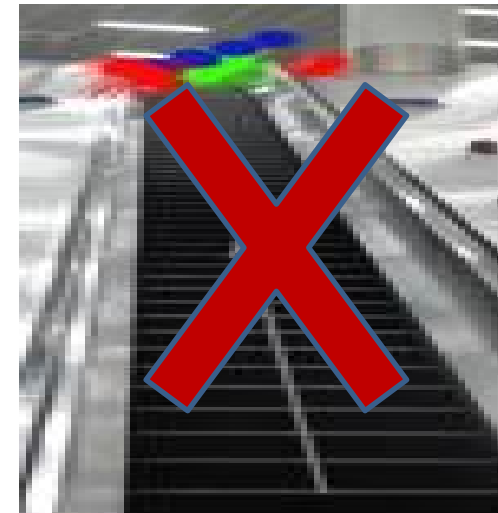
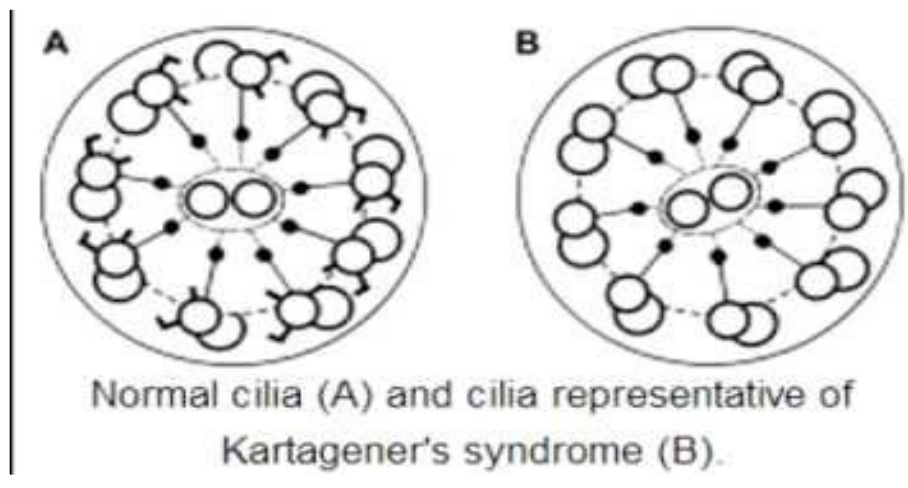
Pseudostratified columnar ciliated is transformed into→ **stratified squamous epithelium**



Medical Application
Kartagener's syndrome
(immotile cilia syndrome)



- It is a genetic defect in dynein arm synthesis → cilia are immotile
→ ↓ mucociliary clearance → chronic respiratory infections occur.



5- Bronchi

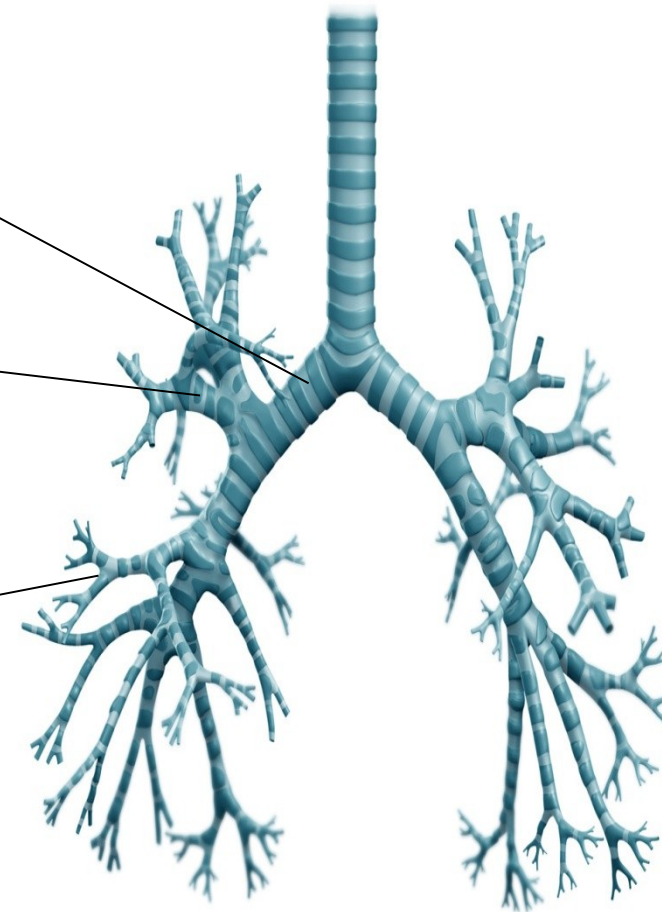


•The bronchial tree consists
of:

1-Primary bronchi
(extrapulmonary) for each
lung

2-Secondary bronchi
(intrapulmonary) for each
lobe

3-Tertiary bronchi for each
pulmonary segment



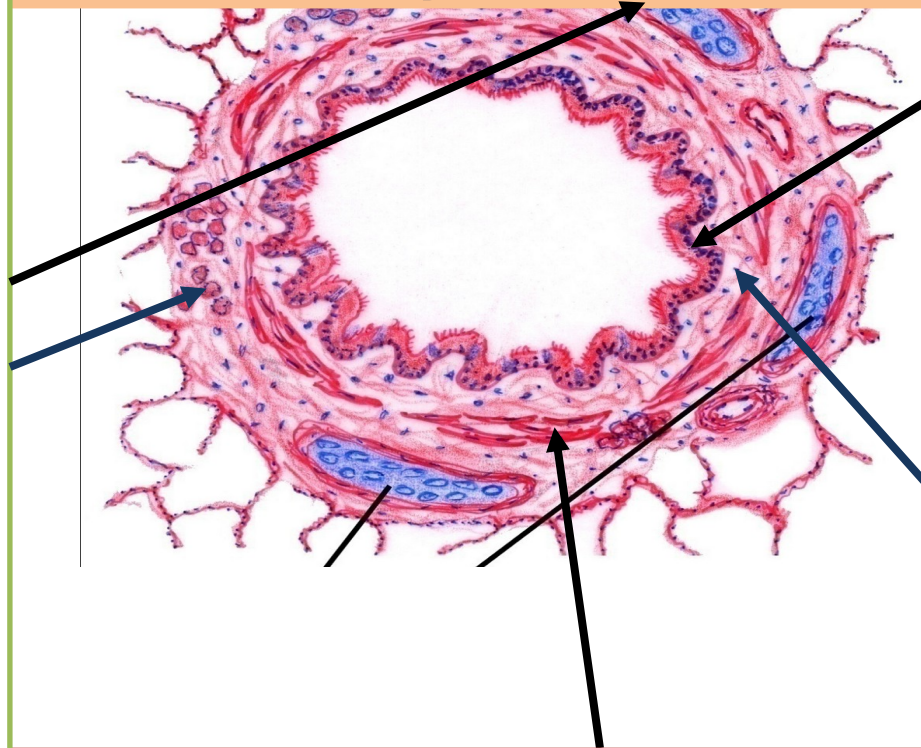
5- Bronchi



Structure of extra-pulmonary bronchi (1ry) is similar to trachea.

Structure of intra-pulmonary bronchi (2ry & 3ry).

3. Adventitia:
dense CT rich in elastic fibers contains:
• **Hyaline cartilaginous plates.**
• **Seromucous glands**
• **Lymphatic nodules**
(BALT=bronchial associated lymphatic tissue).



1. Mucosa:

- **Epithelium:** pseudo-stratified columnar ciliated epithelium with goblet cells.
- **Lamina propria:** CT rich in elastic fibers and contains **solitary lymphoid nodules.**

Musculosa: Well developed, spirally arranged **smooth muscle fibers.**

Lecture Quiz



- ***The vestibule of the nasal cavity is lined by:***
 - a. Respiratory epithelium**
 - b. Olfactory epithelium**
 - c. Stratified columnar epithelium**
 - d. Stratified squamous keratinized epithelium**
 - e. Stratified squamous non keratinized epithelium**



- ***The sustentacular cells of the olfactory epithelium:***

- a. They are basal in position**
- b. They have apical secretory granules**
- c. They have apical motile cilia**
- d. They transmit nerve impulses to olfactory cells**
- e. They have dilated apical vesicle**



- ***K cells in the respiratory epithelium is:***
 - a. Surfactant secreting cell that lines alveoli.**
 - b. Fibroblast in the interalveolar septum.**
 - c. Neuroendocrine cell that lines trachea.**
 - d. Clara cell that lines bronchioles.**
 - e. Mucous secreting cell that lines trachea.**

Summary



- Respiratory system is divided into conducting portion and respiratory portion
- Nasal cavity is divided into **anterior portion (vestibule)** and **posterior portion (respiratory and olfactory areas)** and its lateral wall contains conchae.
- Olfactory epithelium composed of **olfactory bipolar neurons, support cells and stem cells.**
- The nasopharynx is lined with **pseudostratified columnar ciliated epithelium**
- The larynx is lined with respiratory epithelium except the vocal cords and anterior surface of epiglottis are lined by stratified squamous non keratinized epithelium.
- Trachea is formed of 4 layers: mucosa, submucosa, fibrocartilagenous layer and adventitia.
- Intrapulmonary bronchi are formed of 3 layers: mucosa, muscle layer and adventitia containing plates of hyaline cartilage,

SUGGESTED TEXTBOOKS



- **Mescher A (2021):** Junqueira's Basic Histology, Text and Atlas. 16th Edition. Lange medical books/Mc Graw-Hill.
- **Netter's Essential Histology.** 2nd Edition (2013).

THANK

YOU